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(71) Applicants (for all designated States except US):
TRUSTEES OF TUFTS COLLEGE [US/US]; Ballou Hall, On the Green, Medford, MA 02155 (US). **OFS-FI-TEL LABORATORIES** [US/US]; 2000 Northeast Expressway, Norcross, GA 30071 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MATSON, Douglas, M.** [US/US]; 33 Sandrick Road, Belmont, MA 02478

(US). **VENKATESH, Rakesh** [IN/US]; 90 North Street #2, Medford, MA 02155 (US). **MACCHESNEY, John, B.** [US/US]; 2 Cratetown Road, Lebanon, NJ 08833 (US). **STOCKERT, Thomas, E.** [US/US]; 29 Norwood Terrace, Milburn, NJ 07041 (US).

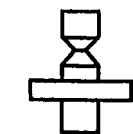
(74) Agent: **ROSEN, Valarie, B.**; Patent Group, Choate, Hall & Stewart LLP, Two International Place, Boston, MA 02110 (US).

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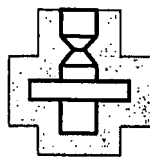
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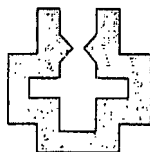
(54) Title: ELECTROPHORETIC CASTING



Coat template



Remove template



Sinter



Mold and remove shell



(57) Abstract: Methods for electrophoretic deposition of molds for casting processes are provided. Electrophoresis is used to deposit very fine particles on a template from a slurry comprising an ionic dispersion agent. The resulting green shell is then dried and sintered to form a mold.

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ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
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Published:

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25 January 2007

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/00505

A. CLASSIFICATION OF SUBJECT MATTER

IPC: B22C 9/00(2007.01);C25D 13/02(2007.01)

USPC: 164/516,517,518,519,361;204/484,490,491

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 164/516, 517, 518, 519,361;204/484,490,491

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,850,733 A (SZAABO) 26 November 1974 (26. 11. 1974), column 2, lines 37+.	1-78
Y	US 5,587,871 A (UE et al) 24 december 1996 (24. 12. 1996), column 2, lines 30+.	1-78
Y	US 5,919,347 A (GAL-OR et al) 06 July 1999 (06. 07. 1999), column 3, 26+.	23-26, 49-52, 75-78



Further documents are listed in the continuation of Box C.



See patent family annex.

Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

29 October 2006 (29.10.2006)

Date of mailing of the international search report

27 NOV 2006

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (571) 273-3201

Authorized officer

Ing-Hour Lin

Telephone No. (703) 308-0651

Kevin Kems AM 1725

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/00505

Continuation of B. FIELDS SEARCHED Item 3:

WEST

search terms: foundry mold, casting shell, casting pattern, electrophoretic deposition

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To:
VALARIE B. ROSEN
PATENT GROUP
CHOATE, HALL & STEWART LLP
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

Date of mailing
(day/month/year) **27 NOV 2006**

Applicant's or agent's file reference

FOR FURTHER ACTION
See paragraph 2 below

International application No.

PCT/US05/00505

International filing date (day/month/year)

07 January 2005 (07.01.2005)

Priority date (day/month/year)

09 January 2004 (09.01.2004)

International Patent Classification (IPC) or both national classification and IPC

IPC: **B22C 9/00(2007.01);C25D 13/02(2007.01)**

USPC: **164/516,517,518,519,361;204/484,490,491**

Applicant

TRUSTEES OF TUFTS COLLEGE

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
Facsimile No. (571) 273-3201

Date of completion of this opinion
29 October 2006 (29.10.2006)

Authorized officer

Ing-Hour Lin

Karin Kern AM1725

Telephone No. (703) 308-0651

Form PCT/ISA/237 (cover sheet) (April 2005)

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US05/00505

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

a. type of material

- ☐ a sequence listing
☐ table(s) related to the sequence listing

b. format of material

- ☐ on paper
☐ in electronic form

c. time of filing/furnishing

- ☐ contained in the international application as filed.
☐ filed together with the international application in electronic form.
☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US05/00505

Box No. V Reasoned statement under Rule 43 bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims <u>1-78</u>	YES
	Claims <u>NONE</u>	NO
Inventive step (IS)	Claims <u>NONE</u>	YES
	Claims <u>1-78</u>	NO
Industrial applicability (IA)	Claims <u>1-78</u>	YES
	Claims <u>NONE</u>	NO

2. Citations and explanations:

Claims 1-22, 27-48 and 53-74 lack an inventive step under PCT Article 33(3) as being obvious over Szabo in view of Ue et al. Szabo (col. 2, lines 37+) teaches the claimed method of forming a shell on a template or conductive coated wax pattern and the claimed casting mold using the claimed method, comprising the use of electrophoretic deposition of colloidal charged refractory particles under the controlled direct current and voltage for forming shell on the conductive coated wax pattern in order to form a casting mold for casting molten metal including preheating the mold before pouring the molten metal into the mold, the suspension or electrolytic solution can be aqueous or non-aqueous and colloidal refractory particles includes silica and alumina. Szabo fails to teach the use of effective salt of monovalent cation. However, Ue et al (col. 2, lines 30+) teach the use of effective salt of monovalent cation such as sodium ion of 5wt% in the electrolyte for the purpose of imparting charge to the colloidal particles such as aluminosilicate having controlled fine size between 3 to 150 nm suspended in the non-aqueous slurry including solution of methanol and ethanol for the purpose of improving dielectric breakdown voltage (spark voltage) greater than 80V at applied current of 5 mA. It would have been obvious to one having ordinary skill in the art to provide Szabo the use of electrolyte solution including effective salt and controlled fine size of colloidal particles as taught by Ue et al in order to effectively form foundry molds by the electrophoretic deposition.

Claims 23-26, 49-52 and 75-78 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of Gal-Or et al. Szabo in view of Ue et al fails to teach the use of low porosity for the multilayer deposition for the shell. However, Gal-Or et al (col. 3, lines 26+) teach the use of low porosity for the multilayer deposition for the shell for the purpose of producing green shell having porosity less than 30% and less than 2% for the fired body; and depositing each microlayer in a different suspension. It would have been obvious to one having ordinary skill in the art to provide Szabo in view of Ue et al the use of low porosity for the multilayer deposition for the shell as taught by Gal-Or et al in order to effectively form foundry molds by the electrophoretic.

Claims 1-78 meet the criteria set out in PCT Article 33(4), and thus having industrial applicability because the subject matter claimed can be made or used in industry.